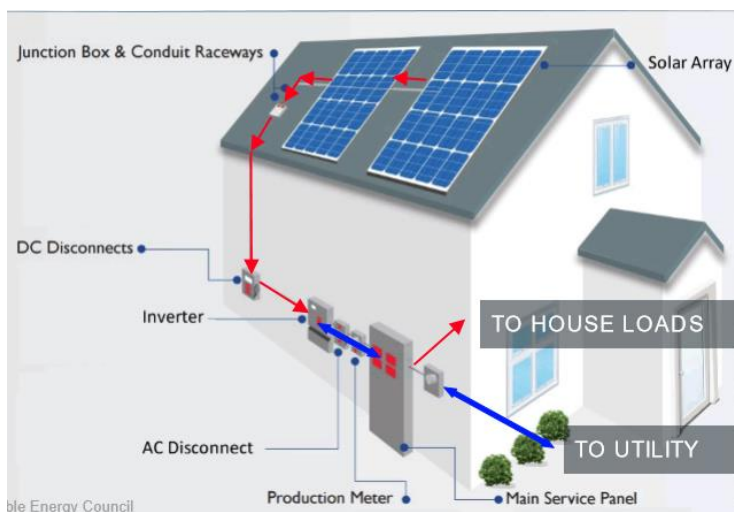


Solar Panels (Grid Tied Systems)

Examples of Photovoltaic systems (P.V. systems) i.e. solar panels. Solar energy systems are systems that are designed to harness solar energy to generate thermal and/or electrical energy through the use of photovoltaic panels and associated components.



EXAMPLE OF GRID-TIED SYSTEM (Connected directly to utility grid, no battery storage)



Photovoltaic systems (PV) or “Solar Panel systems are designed for many functions such as:

- 1). To provide space heating and/or cooling;
- 2). To provide hot water heating;
- 3). To provide swimming pool heating

The code has several requirements for each type of use. This handout is intended to provide some general guidelines.

NOTE: This system is designed to reduce the amount of power required from the utility. Depending on the size of the system the amount of power generated may exceed that of the power demand. When this happens the system will be exporting electricity back to the utility grid. Please contact your utility provider for any questions regarding compensation or benefits that may be provided. The following are links for assistance

Mid American Energy – <https://www.midamericanenergy.com/private-generation.aspx>

Consumers Energy - <https://new.consumersenergy.com/residential/renewable-energy>

This system will not generate power¹ during a power outage unless the system includes a battery backup. Photovoltaic systems will shut off during grid power outages as a safety feature so as not to energize utility electric line that are assumed to be non-energized by utility staff.

¹Even though the system is shut down the panels and their leads (typically 18" in length) have the potential of being energized.

Photovoltaic systems can be designed with a battery backup (UPS system) to operate selected circuits in a building for hours or days during a utility outage. Circuits such as furnace, refrigerator, and/or a general use circuit.

SUBMITTAL REQUIREMENTS

Overview of permit submittal documents

1. Permit application
2. Site plan if panels are not installed on an existing structure
3. Roof system layout plan (site plan not required if system on roof)
4. Structural Engineering documents if on structure
5. Technical Data Sheets of panels, modules, inverter and rack system
6. Electrical schematic plan to include size of wires, types of wires, disconnects, etc.
7. Interconnectivity agreement with electrical utility company ([see above website links](#))
8. Signage requirements



1. Permit Application

An Electrical permit application is required to be submitted along with submittal documents.

A Building permit is required to be submitted if structural changes are needed. The permit application required is for Additions & Alterations (Residential) and can be found at:

<http://www.ankenyiowa.gov/departments/planning-and-building/building-information/permit-applications-guidelines>

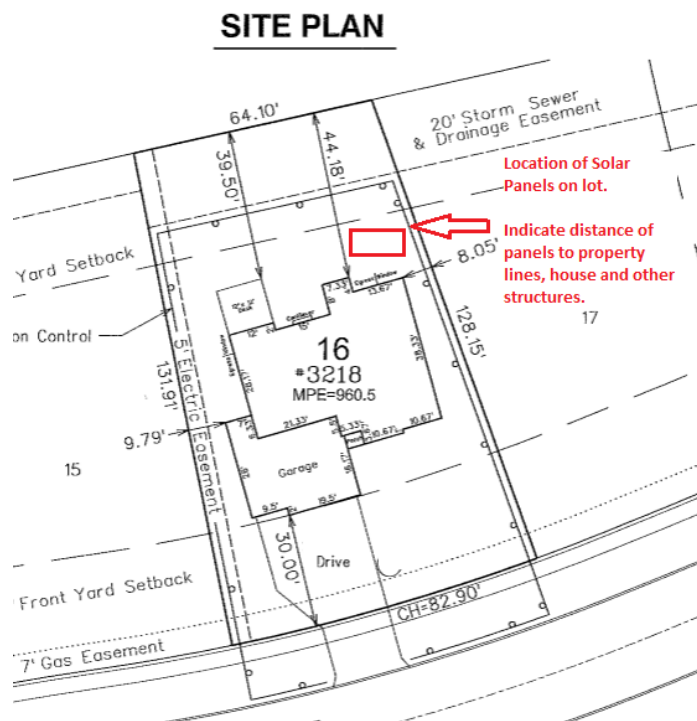
Applications may also be obtained from the following:

Public Safety Building
222 W. 1st Street
Ankeny, Iowa 50023

Staff can also be reached at 515-963-3550



2. Site plan if panels are not installed on an existing structure



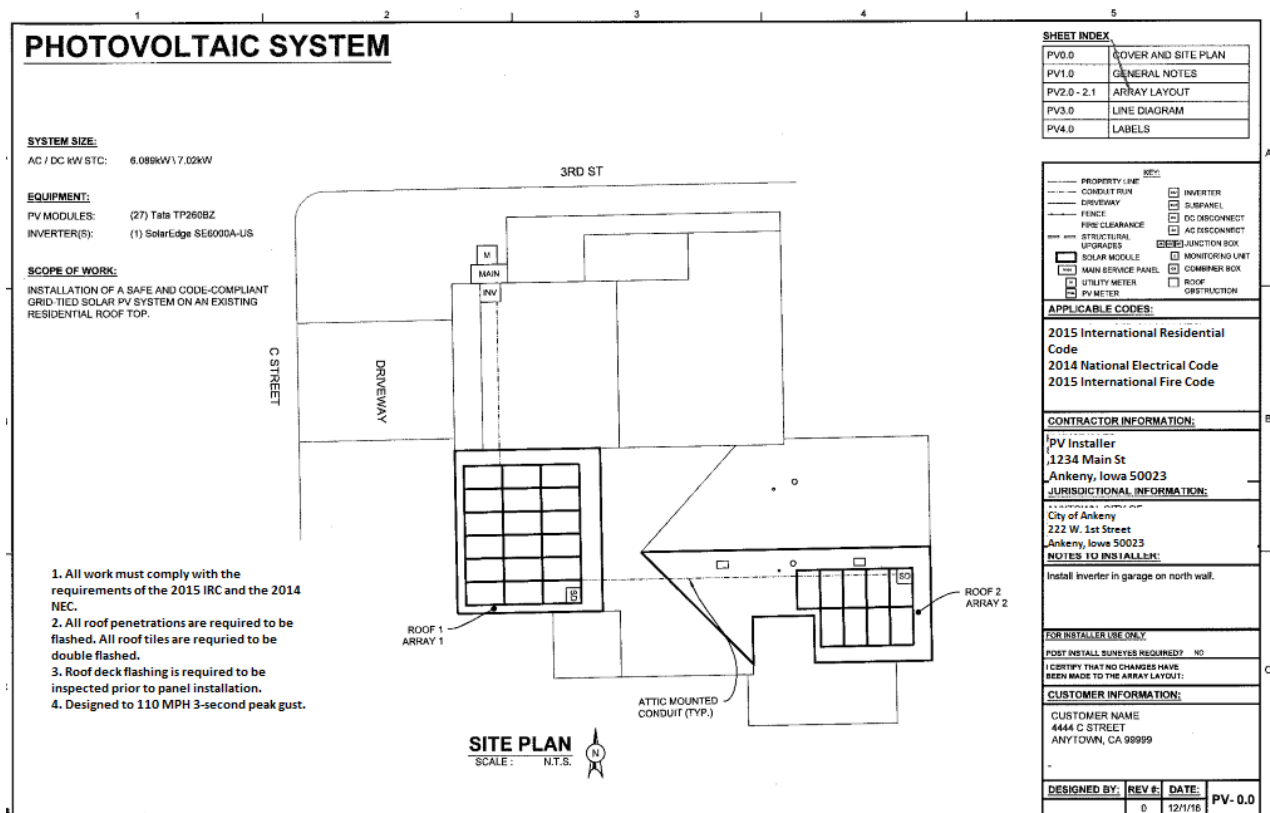
Panels located in a yard are treated as “Accessory” structures for Zoning Code purposes.

This means the panels must be:

- 1) In the rear yard
- 2) Not located in any easements
- 3). Be 3 feet from a property line
- 4). Cannot exceed 12 feet in height
- 5). If on corner lot must conform to the front yard setback regulations on both streets.



3. Roof system layout plan

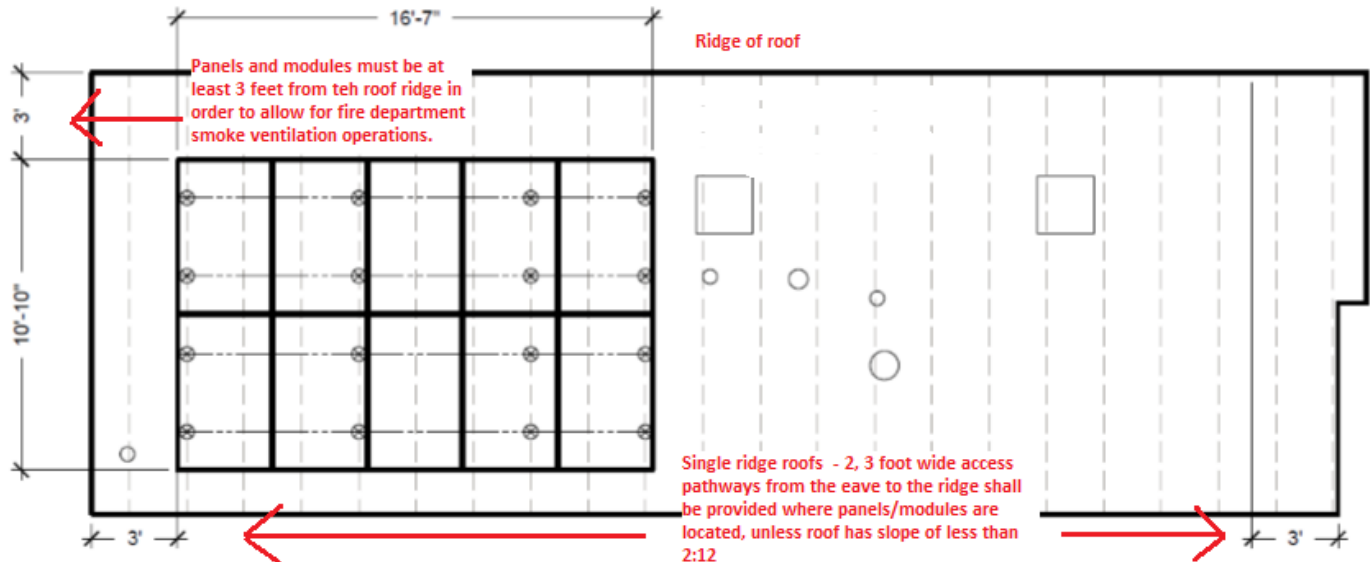


Example of Roof system layout

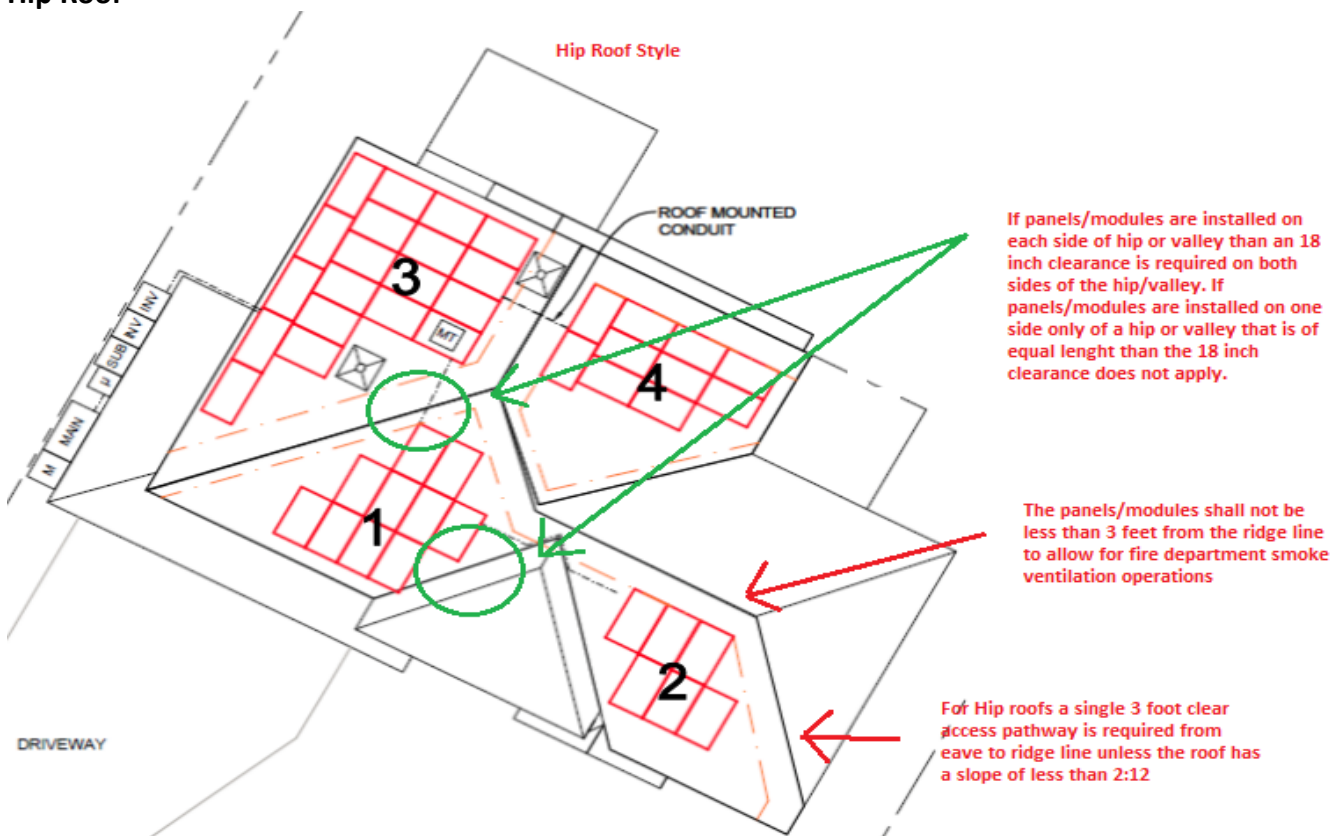
The roof system layout needs to provide the following items:

- A. The location of the solar panels on the actual roof as well as junction boxes and rapid shutdown.
- B. Location of any chimneys, plumbing vents, attic ventilation, peaks, valleys and ridge lines.
- C. Location of Inverter, a/c disconnect, combiner box, dc disconnect, main power disconnect, etc.
- D. Type of roof materials, location of DC or AC wiring (also noting if surface mounted or other method)
- E. Access pathways as required by the IRC (see the following).

Single Ridge Roof



Hip Roof



- NOTE:** 1. Each photovoltaic array is limited to 150 feet by 150 feet. Multiple arrays shall be separated by a clear access pathway not less than 3 feet in width.
2. Roof access points shall be located in areas that do not require the placement of ground ladders over openings such as windows or doors, located at strong points of building construction and where the access point does not conflict with overhead obstructions such as tree limbs, wires and signs.
3. Detached garages and accessory structures to one & two family dwellings are exempt from the access pathway requirements.



4. Structural Engineering

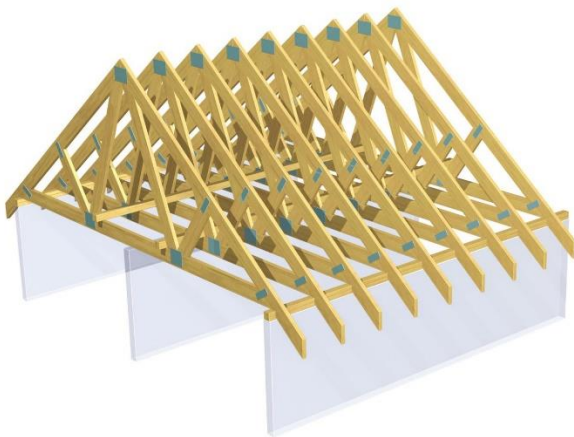
NOTE: A structural engineers report is required to be submitted with the permit application. The existing roof system is required to be analyzed by a licensed professional in order to determine whether or not the existing structure is capable of supporting the increased loads from the solar panel system.



Residential applications typically involve a pitched roof in which solar panels are mounted parallel to the roof pitch. The gravity loads of the solar panels can magnify the uniform loads existing on the roof by concentrating them as point loads. The same holds true for wind loading, as the wind uplift is accumulated through the solar array and directed to the posts that support the solar panel. Also, depending on the roof geometry, the solar panel may act as a sail and catch wind from under the panel, creating very high uplift loads. In some applications, solar panels are put on flat roofs. To achieve higher efficiency, the photovoltaic panels will be posted to the roof such that the panels are at a pitch angled toward the sun. With this geometry, snow can accumulate on the solar array, but can also slide off the panel and create a drift on the low side of the panel. Further, wind can create many different loading scenarios in roof applications.



Yet another concern is that solar panels are often attached to rafters or trusses with lag screws that must land in the center of a 1.5-inch-wide top chord. Depending on the diameter of the connector, a repair may be required due to the section loss of the wood in the top chord. It is highly recommended that all connections of solar panels be made into blocking that is run between trusses, thus avoiding potential damage to the structural integrity of the truss or rafter. This not only prevents the drilling of trusses, but also distributes any point loads between two trusses and decreases the severity of any repairs.



Different types of roof structural systems play a key in how they perform. For instance trusses are different than stick build or I-joists.

Other factors that may need to be taken into account is the number of shingle layers on the roof or the weight of the solar arrays, etc.

2015 IRC Section 802.10.4 states "... Alterations resulting in the addition of load such as HVAC equipment water heater that exceeds the design for the truss shall not be permitted without verification that the truss is capable of supporting additional loading."



Mechanical Properties

Cells	6 x 10
Cell Number	LS
Cell Type	Monoclonal / Fused
Cell Dimensions	156.75 x 156.75 mm
n of Reactor	12 (Multi-Try Reactor)
Dimensions (L x W x H)	1840 x 1000 x 40 mm
Front Load	6000 Pa
Rear Load	5400 Pa
Weight	17.0 ± 0.3 kg
Connector Type	Genova MCA P07 (Max P1457 (4) Female P1487)
Attachment Base	P167 with 3 kg/dyns diodes
Length of Cables	2 to 1000 mm
Front cover	High transmission transparent glass
Frame	Anodized aluminum with protective black

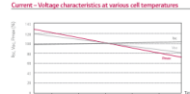
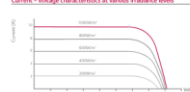
Certifications and Warranties

Certifications	ISO 9001 IEC 61215, IEC 61730-1&2 IEC 62716 (Ammonia Test) IEC 61701 (Salt Mist Corrosion Test)
Module Fire Rating	Class C
Product Warranty	12 Years
Output Warranty of Power (Manufacturer's Tolerance : ± 5%)	Linear Warranty

¹¹⁾ 1st year 30%, 2) After 2nd year 0.25% annual depreciation, 3) 0.13% for 25 years.

AGCT	45 ± 3 °C
Phase	-0.38 %/°C
Y _{AGCT}	-1.24 %/°C
Y _{AG}	0.03 %/°C

Current-voltage characteristics at various irradiance levels



Electrical Properties (STC²⁵)

Module Type	300 W
Maximum Power (P _{max})	300 W
MPPT Voltage Range (V)	32.5
MPPT Current Range (A)	0.26
Open Circuit Voltage (V _{oc})	39.7
Short Circuit Current (A _{sc})	9.70
Module Efficiency (%)	18.3
Operating Temperature (°C)	-40 ~ +85
Maximum System Voltage (V)	1000
Maximum Series Fuse Rating (A)	20
Power Tolerance (%)	0 ~ +3

*STC (Standard Test Condition): irradiance 1000 W/m², Module Temperature 25 °C, AMB 15 °C
 The temperature coefficient is measured and determined by IEC 60904-2 and module data sheet.
 The typical change in module efficiency at 250 W/m² is related to 1000 W/m² is -0.5%.

Electrical Properties (NAC)	
Module Type	

Maximum Power Pin(P ₀)	222
MPP Voltage Vmpg (V)	30.1
MPP Current Impg (A)	7.38
Open Circuit Voltage Voc (V)	36.0
Short Circuit Current Isc (A)	7.83

* MPP (Normal Operating Cell Temperature) Irradiance 800 W/m², ambient temperature 20 °C, wind speed 1



Additional highlights

- RS-485 communication interface (for connection to laptop or data logger)
- Available with the optional VSN300 Wifi Logger Card for easy and affordable wireless monitoring
- Compliant with NEC 690.12 when used with ABB's Rapid Shutdown device
- Comes standard with DC Arc Fault Circuit Interrupter (AFCI) to comply with NEC 690.11



Technical data and types

System Specifications		PVI-6000-OUTD-US			PVI-6000-OUTD-US		
Maximum input power	6000W			6000W			
Maximum output power	6000W			6000W			
Input and output voltage	200V	240V	277V	200V	240V	277V	
Input and output current	30A			30A			
Maximum input voltage	270V			270V			
Maximum output voltage	270V			270V			
Maximum input current	30A			30A			
Maximum output current	30A			30A			
Maximum input power factor	0.95			0.95			
Maximum output power factor	0.95			0.95			
Maximum input voltage range	140-270V			140-270V			
Maximum output voltage range	140-270V			140-270V			
Maximum input current range	10-30A			10-30A			
Maximum output current range	10-30A			10-30A			
Maximum input power range	0-6000W			0-6000W			
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Maximum input current range	10-30A			10-30A			
Maximum output current range	10-30A			10-30A			
Maximum input power range	0-6000W			0-6000W			
Maximum output power range	0-6000W			0-6000W			
Maximum input voltage range	140-270V			140-270V			
Maximum output voltage range	140-270V</						

Enphase® M215 Microinverter // DATA

INPUT DATA (DC)		M215-60-ZLL-S22-K, M215-60-ZLL-S25-K	
Commonly used module pairings ¹	90V - 270V - VAC		
Maximum input DC voltage	48 V		
Peak power tracking voltage	27 V		
Operating range	16 V - 48 V		
Min/Max start voltage	22 V / 48 V		
Max DC short circuit current	18 A		
OUTPUT DATA (AC)		Q208 VAC	Q240 VAC
Peak output power	225 W	225 W	225 W
Power (per terminal output power)	215 W	215 W	215 W
Nominal output current	1.03 A (rms at nominal voltage)	1.03 A (rms at nominal voltage)	1.03 A (rms at nominal voltage)
Nominal voltage	60 V / 153-229 V	240 V / 211-264 V	
Nominal frequency/range	60.0 / 57.41-61 Hz	60.0 / 57.41-61 Hz	
Extended frequency range ²	57.42-62 Hz	57.42-62 Hz	
Power factor	>0.95	>0.95	
Maximum output per 20 A branch circuit	25 (two phase)	17 (single phase)	
Maximum output fault current	850 mA rms for 5 cycles	850 mA rms for 5 cycles	
EFFICIENCY			
CEC weighted efficiency, 240 VAC	96.5%		
CEC weighted efficiency, 208 VAC	96.5%		
Peak inverter efficiency	96.5%		
Static MPPT efficiency (weighted, reference EN50535)	99.4 %		
Night time power consumption	65 mW max		
MECHANICAL DATA			
Ambient temperature range	-40°C to +40°C		
Dimensions (WxHxD)	119 mm x 173 mm x 32 mm (without mounting brackets)		
Weight	1.7 kg (4.0 lbs)		
Cooling	Natural convection - No fans		
Enclosure environmental rating	Outdoor - NEMA 6		
Connector type	M215-60-ZLL-S22-K, M215-60-ZLL-S25-K AmpHorn IAC		
FEATURES			
Compatibility	Compatible with 80-watt PV modules		
Communication	Power line		
Integrated ground	The DC circuit makes the requirements for ungrounded PV arrays in NEC 690.3.5. Equipment ground is provided in the Energy Cables. No additional GEC ground is required. Ground fault protection (GFP) is integrated into the inverter's Enliven Manager and MyInverter monitoring options		
Monitoring			
Compliance	UL1818/IEEE1547 FCC Part 15 Class B, CAN/CSA-C22.2 No. 0-M91, 0-446, and 0-107-1 This product is UL Listed as an Inverter for PV System Equipment and conforms with NEC 690.3 and NEC-2007 sections 690.3.5 and 690.3.5-100. Also see 158 Paper (Shuntless) of PV Safety for AC and DC connections, when installed according to manufacturer's instructions.		

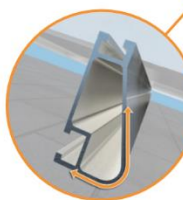
Ex: Micro Inverter/Power Optimizer



Solar Is Not Always Sunny

Over their lifetime, solar panels experience countless extreme weather events. Not just the worst storms in years, but the worst storms in 40 years. High winds capable of ripping panels from a roof, and snowfalls weighing enough to buckle a panel frame.

XR Rails are the structural backbone preventing these results. They resist uplift, protect against buckling and safely and efficiently transfer loads into the building structure. Their superior spanning capability requires fewer roof attachments, reducing the number of roof penetrations and the amount of installation time.



Force-Stabilizing Curve

Sloped roofs generate both vertical and lateral forces on mounting rails which can cause them to bend and twist. The curved shape of XR Rails is specially designed to increase strength in both directions while resisting the twisting. This unique feature ensures greater security during extreme weather and a longer system lifetime.

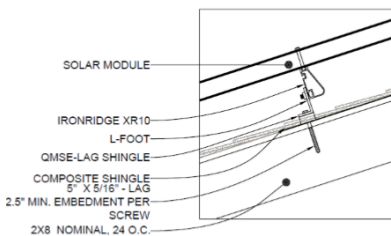
Compatible with **Flat & Pitched Roofs**

Corrosion-Resistant Materials

NOTES:

1. Rooftop mounted panels/modules shall be tested, listed and identified with a fire classification in accordance with UL 1703.
2. Roof penetrations shall be flashed and sealed per IRC chapter 9.
3. Manufactures roof rail system is required to be provided along with inverters, panel arrays and power optimizer/micro inverter information.
4. Mounting installation guidelines are required to be provided

NOTE:
MODULES SHALL NOT BE GREATER THAN 8
INCHES ABOVE ROOF COVERING



2 MOUNTING DETAIL

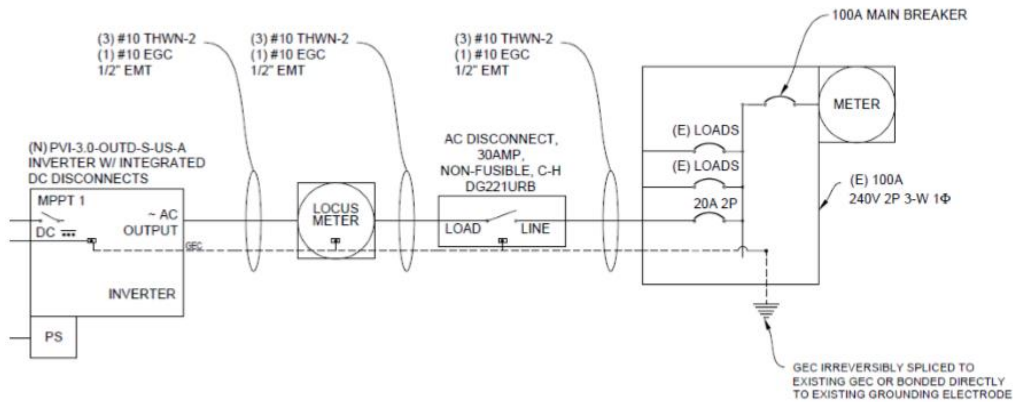
Ex: Mounting detail



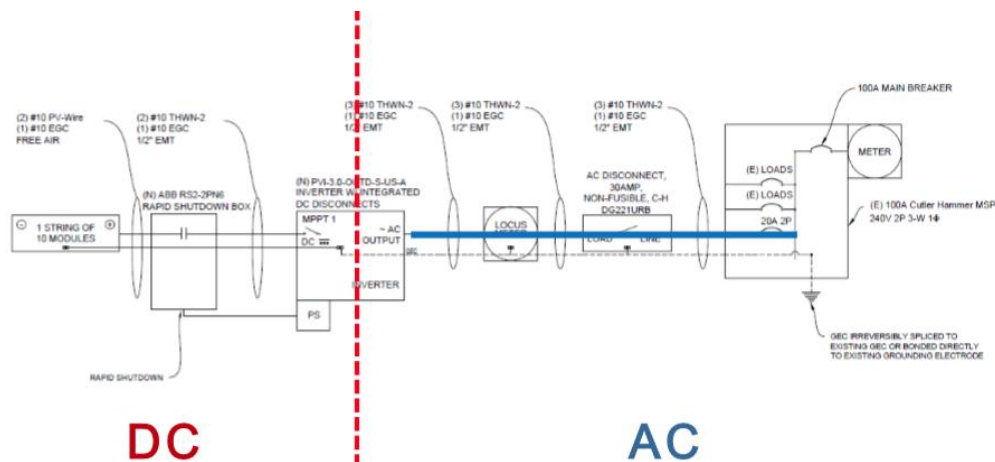
6. Electrical schematic plan to include size of wires, disconnect, types of wires, list of all equipment and components and manufacturers cut sheets of equipment/components.



A State of Iowa Licensed Electrician is required to obtain the electrical permit and perform the installation. The information provided does not reflect all code related items or requirements. The following is just a generic example with some key notes.



Example of Line diagram



Example of Line diagram

USE-2 Wire is allowed to be used however if the inverter is a transformerless inverter than PV wire must be used

GENERIC BASIC NOTES:

- The modules and rack are required to be bonded. Two methods are allowed:
 - Use the rack to ground/bond the modules
 - Use an Equipment grounding conductor to ground/bond the modules
- The module/rack assembly must be listed for bonding per UL 2703, if using method A
- The equipment grounding conductor being used is connected to the modules/rack per the manufacturer's installation instructions.
- If racking system does not meet UL 2703 then each splice is required to be bonded together.
- If racking system is not used for bonding purposes then each module must be bonded via an Equipment Grounding Conductor or other approved method.
- Grounding Electrode Conductor must be irreversibly spliced to existing grounding electrode conductor or bonded directly to existing grounding electrode from the Inverter to the main disconnect.



7. Interconnectivity agreement with utility company

A copy of the connectivity agreement between the utility company and the property owner is required to be provided at the time of permit submittal.

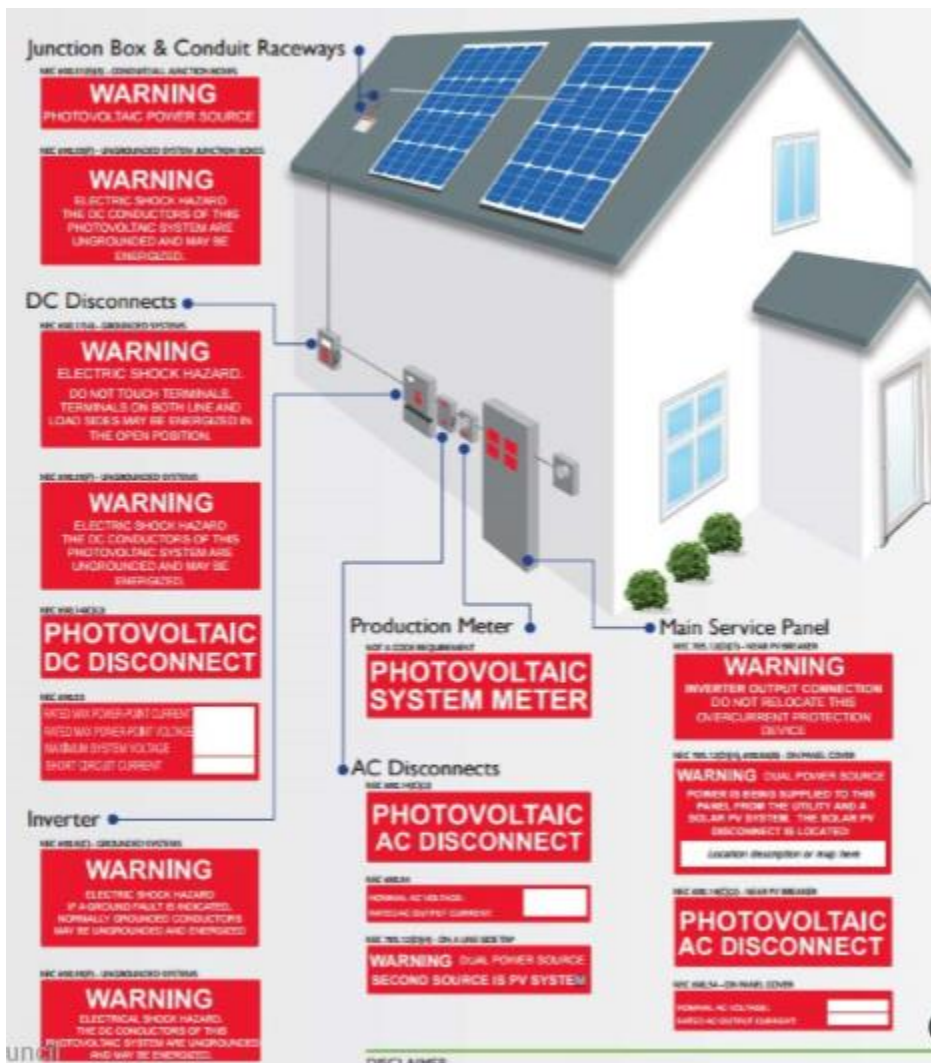
Information and contact information regarding the agreements can be found at:

Mid American Energy – <https://www.midamericanenergy.com/private-generation.aspx>

Consumers Energy - <https://new.consumersenergy.com/residential/renewable-energy>



8. Signage requirements



Signage is required to be installed at:

1. Junction boxes
2. Conduit raceways
3. DC disconnects
4. Inverter
5. AC disconnects
6. Main Service panel
7. Production meter

Please refer to NEC Articles 690 & 705 for signage requirements

This handout is to serve as a guide to what the basic requirements are for PV systems. This handout does not cover all code related items. Each structure is reviewed separately and may require additional items depending on site and structure conditions.